OHIO RIVER BASIN
SANDY RUN, SOMERSET COUNTY

PENNSYLVANIA

LEVEL II

BIGAN DAM

NDI ID NO. PA-237
DER ID NO. 56-94

M. K. BIGAN

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared By
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Contract DACW31-81-C-0012

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

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411059

AUGUST 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Bigan Dam
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Somerset
STREAM	Sandy Run
DATES OF INSPECTION	June 4, 1981 and June 15, 1981
COORDINATES	Lat: 40° 11' Long: 78° 48.2'

ASSESSMENT

The assessment of Bigan Dam is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations and past operational performance.

Bigan Dam appears to be in poor condition and modifications to the dam have apparently been in progress for several years. The reservoir pool is maintained at a reduced level due to a directive from the Commonwealth pending the completion of design modifications to the structure. Due to the questionable condition of the earthen embankment section near the right abutment, the static stability of the structure is questionable. The spillway for the dam is a temporary structure, and a new spillway is planned at the dam. The owner should be urged to complete the construction of the facility as soon as possible. The completion of the structure should include an assessment of the earthen embankment section near the right abutment, and the stability of the section should be evaluated.

The drainline valve was observed to be in the open position during the inspection. Flow through the drainline was discharging beyond the downstream toe of the dam.

Bigan Dam is a high hazard-small size dam. The recommended spillway design flood (SDF) for a dam of this size and classification is in the range of 1/2 PMF to PMF. Based on the downstream potential for loss of more than a few lives, the spillway design flood (SDF) has been selected as the PMF.

The visual observations, review of available data, hydrologic and hydraulic calculations and past operational performance indicate that the Bigan Dam is capable of controlling approximately 50% of the PMF. The spillway is classified as inadequate as it cannot pass the spillway design flood (PMF)

The following recommendations and remedial measures should be instituted immediately.

1. An assessment should be made of the earthen embankment section near the right abutment of the dam. Observations made during the inspection indicate that the material is relatively uncompact and easily erodable. A stability analysis of the earthen embankment section should be made by a registered professional engineer knowledgeable in dam design and analysis.

2. A reduced level in the reservoir should be maintained until the analysis of the embankment and the spillway is completed and construction of modifications are completed.

3. Final construction at the facilities should include final grading of the embankment crest and slopes to include the placement of riprap on the upstream slope as indicated on the design drawings and the removal of the trees on the downstream slope. The top of dam elevation should be consistent along the entire length of the crest with the top of dam elevation equalling the top elevation of the spillway abutments. Protective vegetation should be supplied for the embankment crest and slopes. All proposed modifications should be completed as soon as possible.

4. A regularly scheduled maintenance and operation plan should be prepared and implemented upon completion of the project to insure continued safe operation of the structure.

5. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam.

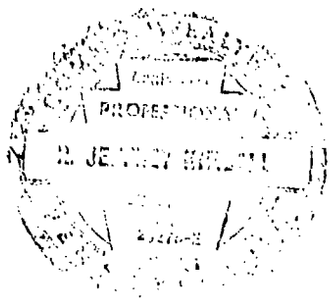
6. A safety inspection program should be implemented with inspections at regular intervals by qualified personnel.

7. Positive upstream closure should be provided for the drainline, or the drainline should be plugged and some other means devised to drain the reservoir. An alternate method for draining the reservoir should not include a pressurized pipe through the embankment.

BIGAN DAM
PA 237

SUBMITTED BY:

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS



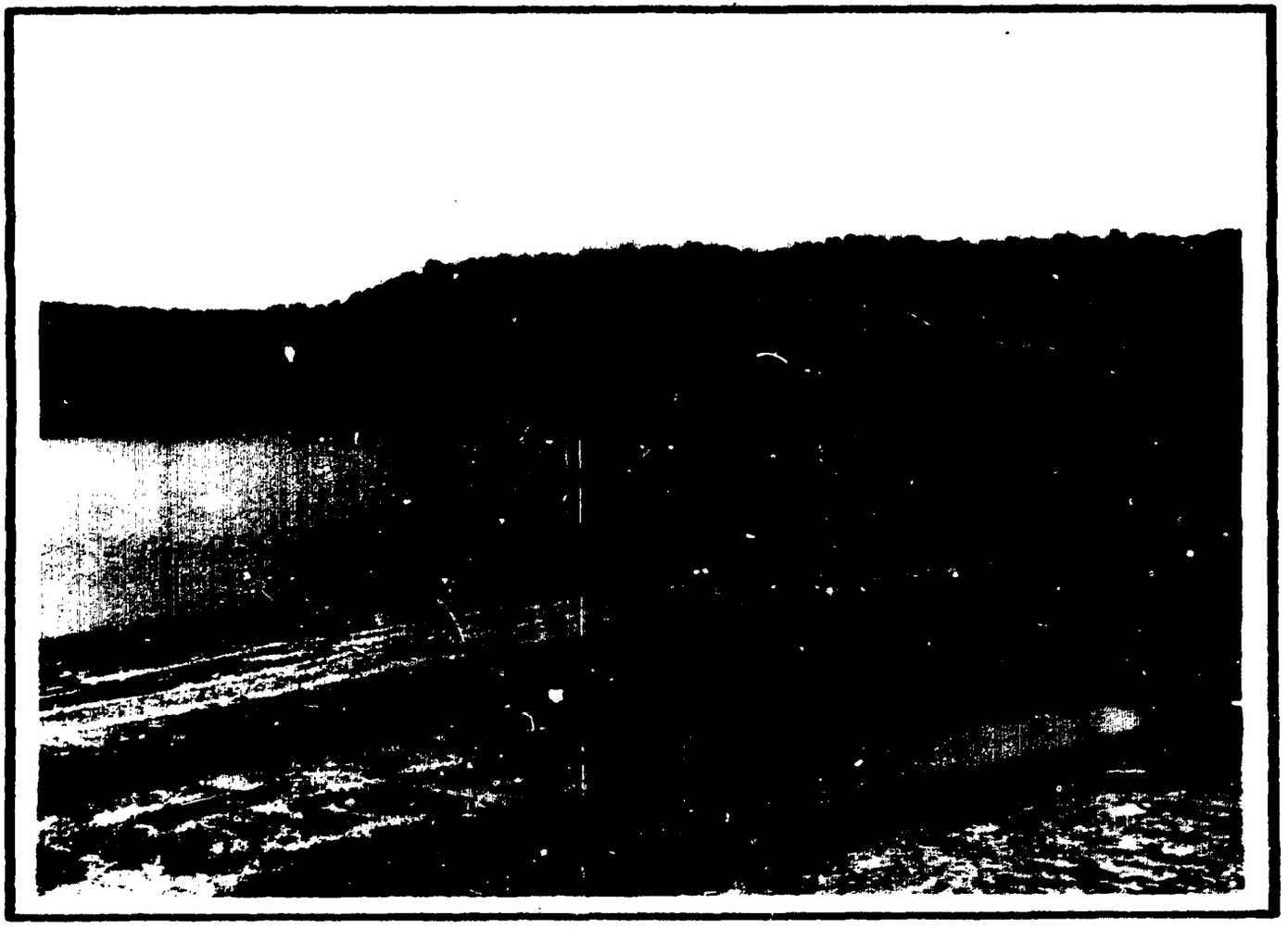
8/6/81
Date

R. Jeffrey Kimball, P.E.

APPROVED BY:

28 Aug 81
Date

JAMES W. PECK
Colonel, Corps of Engineers
District Engineers



Overview of Bigan Dam

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PHASE I
NATIONAL DAM INSPECTION PROGRAM

BIGAN DAM
NDI. I.D. NO. PA 237
DER I.D. NO. 56-94

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Bigan Dam is an earthfill dam, 1800 feet long and 24 feet high. The crest width of the dam varies, with the majority of the crest being 15 feet wide. The downstream slope of the dam varies from 2H:1V to 2.5H:1V. The upstream slope of the dam has a relatively consistent slope of 2H:1V. The dam is still under construction, and no protective vegetation exists on the crest or slopes of the dam.

The spillway for the dam exists near the left abutment of the embankment section. The spillway is still under construction, and a temporary roadway exists at the entrance to the spillway. Three 24" diameter corrugated metal pipes have been placed through the temporary roadway at the entrance to the spillway channel. The spillway consists of an open earth cut trapezoidal channel. A spillway discharge channel, 300 feet long, discharges flows from the spillway into the natural stream beyond the downstream toe of the dam.

The drainline facilities for the reservoir consist of a 12" diameter cast iron pipe through the embankment located approximately 800 feet right of the spillway. The control facility for the drainline exists at the downstream end of the line.

b. Location. The dam is located on Sandy Run, approximately 3.5 miles southeast of Windber, Paint Township, Somerset County, Pennsylvania. Bigan Dam can be located on the Windber, PA, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Bigan Dam is a small size dam (24 feet high, 210 acre-feet).

d. Hazard Classification. Bigan Dam is a high hazard dam. One home is located approximately 500 feet downstream and west of the dam. Two additional homes are located within two miles downstream of the dam. Downstream conditions indicate that the loss of more than a few lives and significant property damage is probable should the structure fail.

e. Ownership. Bigan Dam is owned by Mr. M. H. Bigan. Correspondence should be addressed to:

Mr. M.H. Bigan
421 Bigan Drive
Windber, Pennsylvania 15963
814/467-9700

f. Purpose of Dam. The dam is utilized by the owner for the purposes of fire protection and recreation.

g. Design and Construction History. The dam was originally constructed sometime around 1957 by the owner. Damages to the spillway and embankment occurred in July 1977, due to heavy rains in the Johnstown area. Correspondence in the DER file, dated August 3, 1977, indicates that the owner was notified that an inspection had occurred at the site. The inspection disclosed that the dam had been overtopped and also disclosed several items that were in need of future attention. The owner was requested to retain the services of a registered professional engineer to make an in-depth study of the condition of the dam. No later correspondence was located in the file which reported the results of the study.

Neilan Engineers, Inc., of Somerset, Pennsylvania had been retained to design modifications to improve the condition of the dam, as directed in the August 3, 1977 correspondence between the owner and the Division of Dams and Encroachments.

The modifications designed by the Neilan Engineers, Inc., included the restoration of the embankment and the design of a new spillway for the dam. The embankment modifications included the slopes graded to 2.5H:1V slopes with a 15 foot crest width. The top of dam elevation was 2070.0. Twelve inch riprap was to be placed along the upstream slope of the dam.

The spillway modifications included the construction of a rein-

forced concrete weir with a grouted riprap approach and a concrete channel bottom in the area of the embankment. A 10 foot long grouted riprap section was designed at the outlet for the spillway and the discharge channel protected with 12" diameter riprap. The left bank of the spillway was to be on a 5H:1V slope and the right bank of the spillway on a 10H:1V slope. The crest elevation of the concrete weir was designed to be 2065.0. Overflow pipes were designed to be constructed through the concrete control section, but it was reported by the owner that the overflow pipes were to be deleted from the design.

h. Normal Operating Procedures. The reservoir is currently maintained in a near drained condition. The drainline valve at the structure remains in an open position as directed by the State.

1.3 Pertinent Data.

a. Drainage Area. 2.0 square miles

b. Discharge at Dam Site (cfs).

Maximum flood at dam site (July, 1977)	Unknown
Drainline capacity at normal pool	Unknown
Spillway capacity at top of dam	2710

c. Elevation (MSL) (feet). - Field survey based on an assumed top of dam elevation for the original embankment, 2070.5 feet, design drawings and U.S.G.S. 7.5 minute quadrangle.

Top of dam - low point	2068.2
Top of dam - design height	2070.0
Pool elevation at time of inspection	2059.8
Spillway crest - channel bottom	2060.5
- invert (3) 24" diameter CMP's	2060.5
- top of temporary roadway	2064.3
Maximum pool - design surcharge	2070.0
Upstream portal - 12" diameter cast iron pipe	Unknown
Downstream portal - 12" diameter cost iron pipe	2044.5
Streambed at centerline of dam	Unknown
Maximum tailwater	Unknown
Toe of dam	2044.5

d. Reservoir (feet).

Length of maximum pool	1500
Length of normal pool	1000

e. Storage (acre-feet).

Normal pool	55
Top of dam	210

f. Reservoir Surface (acres).

Top of dam	24.6
Normal pool	15.8
Spillway crest	15.8

g. Dam.

Type	Earthfill
Length (excluding spillway)	1800 feet
Height	24 feet
Top width (minimum)	15 feet
Side slopes - upstream	2H:1V to 2.5H:1V
- downstream	2.5H:1V
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Reservoir Drain.

Type	12" diameter cast iron pipe
Length (approximate)	110 feet
Closure	Gate on downstream end of pipe
Access	Downstream toe
Regulating facilities	Gate valve

i. Spillway. (temporary construction)

Type	Trapezoidal earth cut with discharge channel
Length (bottom width)	38 feet
Crest elevation (channel bottom)	2060.5
Upstream channel	Lake with temporary earthen berm at approach to control section
Downstream channel	Trapezoidal discharge channel to natural stream

SECTION 2
ENGINEERING DATA

2.1 Design. Review of available information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources, revealed that some correspondence and various original design drawings were available for review. Design drawings relative to the modifications to the dam were supplied by the owner, through the owner's engineer (Neilan Engineers, Inc.).

2.2 Construction. Final construction of the modifications to the earthen embankment and spillway are as yet incomplete. Final shaping of the embankment crest and slopes remains to be completed, and the spillway is a temporary structure.

2.3 Operation. No planned construction schedule exists for the dam. Work on the dam and spillway is performed on an unscheduled basis.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Pennsylvania Department of Environmental Resources, Bureau of Dams and Waterway Management and the owner's engineer (Neilan Engineers Inc.).

b. Adequacy. This Phase I Report is based on the visual inspection and hydrologic and hydraulic analysis. Sufficient information exists to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Bigan Dam was conducted by personnel of L. Robert Kimball and Associates on June 4, 1981 and June 15, 1981. Prior to the inspection, the inspection team met with the owner and the owner's engineer, Mr. Lynn Young. Information relative to the proposed design were discussed. The owner's engineer supplied the inspection team with a set of design drawings. Neither the owner nor his engineer accompanied the inspection team during either inspection. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam is still under construction. The majority of fill placement on the embankment appears to be complete. Final shaping of the embankment slopes and crest is required. Surface erosion on the embankment crest and slopes is considerable. Ponding of water was observed on the embankment crest in various locations due to the uneven condition of the crest. It was also observed during the inspection that a significant portion of the embankment is wider than indicated on the design drawings.

It was noted during the inspection that a majority of the downstream slope of the dam ranges from 2H:1V to 2.5H:1V, although several areas along the upstream slope were noted to be relatively steep. A portion of the upstream slope of the dam near the right abutment showed visible tension cracks along the crest of the dam. The embankment section near the right abutment of the dam was observed to be very soft and relatively uncompact. The material in this area was considered as being highly erosive and it was noted that failure of the embankment in this area could potentially occur prior to overtopping of the dam. The placement of riprap on the upstream slope of the dam has not yet been completed. The earthen embankment section to the right of the spillway had a significantly increased crest width. The crest width in the area was greater than 50 feet.

c. Appurtenant Structures. The spillway for the dam is located at the left abutment of the embankment. The spillway is a temporary structure. The spillway is a trapezoidal open cut spillway with a

trapezoidal discharge channel approximately 300 feet long. A temporary earth berm exists along the approach to the channel. Three 24" diameter corrugated metal pipes exist through the earth berm. The berm serves as a roadway across the channel. It was noted during the inspection that during periods of high discharges through the channel, the roadway would quickly erode away. The bottom width of the channel in the area of the embankment was measured to be 38 feet. The side slopes of the control section for the channel were estimated to be 1H:1V. The existing channel slopes are formed by the original embankment. The discharge channel for the spillway appears to be nearly complete with the exception of the placement of riprap in the channel.

The waterlevel in the reservoir was below the existing spillway crest and planned normal pool elevation. The drainline for the reservoir is located approximately 800 feet right of the spillway. The drainline consists of a 12" diameter cast iron pipe. A gate valve exists on the downstream end of the pipe. The valve was in the open position, and flow through the pipe was discharging during the inspection. Flow through the drainline discharges beyond the downstream toe of the dam into the natural stream. Small trees and brush were growing along the downstream slope and beyond the toe in the area between the spillway and the drainline. This condition was not considered as being significant due to the relative width of the embankment in this area. Final sloping of the downstream slope in this area should include the removal of the trees as a precaution against future slope instability in the area.

d. Reservoir Area. The visible portion of the watershed area was observed to be covered almost entirely by forested lands. The watershed slopes in the area of the reservoir were observed to be relatively moderate. The reservoir slopes did not appear to be susceptible to massive landslides, which would affect the storage volume of the reservoir or cause overtopping of the dam by displacing water.

e. Downstream Channel. The downstream channel for the Bigan Dam consists of Sandy Run, which is tributary of the Roaring Fork Creek. Sandy Run converges with the Roaring Fork Creek approximately 1/2 mile downstream of the dam. One home is located approximately 500 feet downstream and west of the dam. Two additional homes are located within two miles downstream of the dam. Downstream conditions indicate the loss of more than a few lives and significant property damage is probable should the structure fail.

3.2 Evaluation. The dam is still under construction. A reduced pool elevation has been maintained at the facility for several years. It is apparent that a majority of the proposed fill has been placed on the embankment. The prolonged time of construction and the lack of

erosion protection on the upstream slope of the dam has allowed deterioration of the upstream slope of the dam to occur in several areas.

It appears as though a 200 foot section of the embankment near the right abutment was placed in a relatively uncompacted manner. The fill material was visibly different from the majority of the embankment, and it was noted that the material was highly erosive and relatively soft. Failure of this section of the embankment was noted as possibly occurring prior to overtopping of the embankment. The low spot on the embankment crest was determined to be in this area.

The spillway is a temporary structure. The evaluation of the hydraulic features associated with this dam were conducted based on the present condition of the spillway.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is presently in a near drained condition. The continued construction at the facility is on an unscheduled basis.

4.2 Maintenance of the Dam. Since the dam is still under construction, no planned maintenance schedule exists for the dam.

4.3 Maintenance of Operating Facilities. No planned maintenance exists. The dam is still under construction and the reservoir drainline is maintained in an open position.

4.4 Warning System in Effect. There is no warning system in effect to warn downstream residents of large spillway discharges or imminent failure of the dam.

4.5 Evaluation. The construction of the dam is as yet not complete. No maintenance or operational procedures are necessary at this time. A planned maintenance and operation program should be prepared and implemented upon completion of the dam.

An emergency action plan should be available for every dam in the high and significant hazard categories. Such plans should outline actions to be taken by the operator to minimize downstream effects of an emergency, and should include an effective warning system. No emergency action plan has been developed.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No detailed information was available relative to the hydraulic and hydrologic design of the dam. It was reported by the design engineer, the Neilan Engineers, Inc., that the C-curve was used in the spillway design.

b. Experience Data. No rainfall, runoff or reservoir level data were available. The dam was overtopped during the July 1977 flood caused by heavy rainfalls in the Johnstown area.

c. Visual Observations. The spillway was under construction. Rough excavation had occurred in the area of the proposed spillway. A temporary roadway (earth berm) existed across the approach to the spillway channel. Three 24" diameter corrugated metal pipes exist through the earth berm. It was the judgement of the inspection team that the analysis of the spillway would assume the rapid deterioration of the earth berm at the approach to the spillway. The spillway channel walls in the area of the control section were cut into the original embankment in the area. The cut slopes were observed to be approximately 1H:1V. The construction of the spillway discharge channel appeared to be nearly complete, except for final dressing of the channel bottom and walls and the placement of riprap in the channel.

The crest of the dam was relatively uneven. The low spot on the embankment crest was determined to be near the right abutment of the dam.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable completion of the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The pool elevation in the reservoir was assumed to be at the invert elevation of the three 24" diameter corrugated metal pipes, 2060.5.

2. The earth berm which exists across the approach to the spillway was assumed to undergo rapid deterioration during initial discharges through the spillway.

3. No discharge was considered through the 12" diameter cast iron pipe drainline.

4. The top of dam was considered to be the low spot elevation, 2068.2. Overtopping of the embankment crest is to be determined through the $L, $V, (HEC-1) program option.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	5793 cfs
Spillway capacity	2710 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) is based on the hazard and size classification of the dam. The recommended spillway design flood for a dam of this size and hazard classification is in the range of 1/2 PMF to PMF. Three homes exist within two miles downstream of the dam. The potential for loss of more than a few lives is probable should the structure fail. Due to the downstream potential for loss of live and significant property damage, the spillway design flood has been selected as the PMF.

Based on the following definition provided by the Corps of Engineers, the spillway is rated as inadequate as a result of our hydrologic analysis.

> Inadequate - All high hazard dams which do not pass the spillway design flood (PMF).

The spillway and reservoir are capable of controlling approximately 50% of the PMF without overtopping the embankment low spot.

5.4 Summary of Dam Breach Analysis. Failure of the embankment is considered possible during a storm of a magnitude of less than 50% of the PMF. Due to observations made during the inspection, failure of the embankment in the area of the right abutment was considered probable due to piping in the area. Approximately 200 feet of the embankment in the area of the right abutment was observed to consist of relatively uncompact pervious material.

A dam breach analysis was not conducted since the location of the breach (right abutment) would be such that only a partial failure would occur. It was the judgement of the evaluating engineer that the partial failure would not significantly increase the downstream flooding

from that which would exist just prior to the partial failure. The reservoir elevation would be less than 2063.0, and the bottom of the breach would be estimated at approximately 1063.0.

It is estimated that design modifications to the spillway would enable the spillway to safely discharge approximately 3300 cfs (59% of the PMF). Since the modified spillway was considered as being capable of safely passing in excess of 50% of the PMF, no breach analysis was required. The existing temporary and planned modified spillways are considered inadequate, but not seriously inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The earth embankment near the right abutment of the structure consists of relatively uncompact and easily erodable material. Several areas on the embankment were noted to be very soft, and small slides were noted on the upstream slope of the dam. A tension crack was observed in this area along the upstream edge of the crest. Failure of the embankment in the area of the right abutment was considered probable due to piping. The pool elevation in the reservoir is maintained at a reduced level, and no determination could be made relative to seepage in this area. No obvious seepage was observed on the downstream slope or along the toe of the embankment in the areas at or below the reduced pool elevation. Based on observations made during the inspection, relative to the embankment, the static stability of the structure at proposed normal pool conditions is questionable.

b. Design and Construction Data. No information was available in the DER files relative to the original construction of the dam. Original design drawings were available for review. Information relative to the proposed modifications to the structure were supplied by the owner's engineer. Pertinent design drawings are included in Appendix E of this report. The modifications were designed by the Neilan Engineers, Inc., of Somerset, Pennsylvania.

c. Operating Records. No operating records exist for this dam.

d. Post Construction Changes. Modifications to the original structure are currently in progress. The modifications to the original dam were required due to a partial failure of the structure during heavy rainfall associated with the July 1977 flooding in and around the Johnstown area. The owner was ordered to retain a professional engineer to design modifications to the dam and work has been in progress relative to design and construction since 1977.

e. Evaluation. Based on observations made during the inspection, the static stability during proposed normal pool conditions is questionable. An in-depth analysis of the embankment is required to determine the actual condition of the embankment relative to the stability of the structure.

No seepage was observed on the downstream slope or along the toe of the dam on those portions of the embankment which are below the current pool elevation. No final assessment relative to potential seepage could be made at the time of inspection due to the reduced pool level in the reservoir.

A construction schedule should be prepared to insure that final construction at the dam is completed within a reasonable period. The potential exists for excessive rainfall to raise the pool level in the reservoir to an elevation which could begin to cause concern relative to the stability of the structure, due to the observed conditions of the embankment near the right abutment.

f. Seismic Stability. The dam is located in seismic zone 1. Normally it may be assumed that a dam in this zone presents no hazard from earthquake provided static stability conditions are satisfactory and conventional safety margins exist. No known seismic stability analyses have been performed. Due to the questionable condition of the earthen embankment near the right abutment, no assessment of the seismic stability of the structure can be made at this time.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. Bigan Dam appears to be in poor conditon and modifications to the dam have apparently been in progress for several years. The reservoir pool is maintained at a reduced level due to a directive rrom the State pending the completion of design modifications to the structure. Due to the questionable condition of the embankment section near the right abutment, the static stability of the structure during proposed normal pool conditions is questionable. The spillway for the dam is a temporary structure, and a new spillway is planned at the dam.

The drainline valve was observed to be in the open position during the inspection. Flow through the drainline was discharging beyond the downstream toe of the dam.

The construction of modifications to the dam has been an on-going process for several years. Due to the questionable stability of the embankment section near the right abutment and the potential for increased pool levels in the reservoir, the owner should be urged to complete the construction of the facility as soon as possible. The completion of the structure should include an assessment of the embankment near the right abutment, and the stability of the section should be evaluated.

Bigan Dam is a high hazard-small size dam. The recommended spillway design flood (SDF) for a dam of this size and classification is in the range of 1/2 PMF to PMF. One home is located approximately 500 feet downstream and west of the dam. Two additional homes are located within 2 miles downstream of the dam. Based on the downstream potential for loss of more than a few lives, the spillway design flood (SDF) has been selected as the PMF.

The visual observations, review of available data, hydrologic and hydraulic calculations and past operational performance indicate that the Bigan Dam is capable of controlling approximately 50% of the PMF. The spillway is classified as inadequate as it cannot pass the spillway design flood (PMF).

b. Adequacy of Information. Sufficient information is available to complete a Phase I report.

c. Urgency. The recommendations suggested below should be implemented as soon as possible.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. An assessment should be made of the earthen embankment section near the right abutment of the dam. Observations made during the inspection indicate that the material is relatively uncompact and easily erodable. A stability analysis of the earthen embankment section should be made by a registered professional engineer knowledgeable in dam design and analysis.

2. A reduced level in the reservoir should be maintained until the analysis of the embankment and the spillway is completed and construction of modifications are completed.

3. Final construction at the facilities should include final grading of the embankment crest and slopes to include the placement of riprap on the upstream slope as indicated on the design drawings and the removal of the trees on the downstream slope. The top of dam elevation should be consistent along the entire length of the crest with the top of dam elevation equalling the top elevation of the spillway abutments. Protective vegetation should be supplied for the embankment crest and slopes. All proposed modifications should be completed as soon as possible.

4. A regularly scheduled maintenance and operation plan should be prepared and implemented upon completion of the project to insure continued safe operation of the structure.

5. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam.

6. A safety inspection program should be implemented with inspections at regular intervals by qualified personnel.

7. Positive upstream closure should be provided for the drainline, or the drainline should be plugged and some other means devised to drain the reservoir. An alternate method for draining the reservoir should not include a pressurized pipe through the embankment.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Bigan Dam COUNTY Somerset STATE Pennsylvania ID# PA 237

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION June 4, 1981 WEATHER Overcast with rain TEMPERATURE 60°
June 15,1981 Clear and warm 70°

POOL ELEVATION AT TIME OF INSPECTION 2059.8 M.S.L. TAILWATER AT TIME OF INSPECTION Not applicable M.S.L.

A-1

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

O.T. McConnell RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	A tension crack exists along the upstream edge of the crest on the earthen embankment section, near the right abutment.	Portions fo the upstream slope in the area have slid away. The observed slides are not extensive.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	A portion of the earthen embankment section near the right abutment of the dam appeared relatively uncompacted. Erosion of the upstream slope in this area was evident.	The earthen section near the right abutment of the dam should be assessed relative to stability.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The dam is technically still under construction. The embankment crest is irregular.	The embankment crest should be graded to an elevation consistent with the top of the spillway abutments prior to completion of the project.
RIPRAP FAILURES	None. Riprap is planned to be placed on the upstream face of the dam.	Riprap is planned for the upstream slope.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	The dam is technically still under construction.	Vegetation should be provided for the crest and embankment slopes prior to completion of the project.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Under construction.	
ANY NOTICEABLE SEEPAGE	No observed seepage during the inspection.	The pool level of the reservoir is maintained at a reduced level. The facility should be reinspected when the pool elevation is at normal pool.
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS - NOT APPLICABLE

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS - NOT APPLICABLE

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not applicable.	
INTAKE STRUCTURE	Not observed.	
OUTLET STRUCTURE	No formal outlet structure exists. The 12" diameter drainline outlets near the downstream toe of the dam.	Valve exists at the downstream end of the pipe.
OUTLET CHANNEL	Natural stream below dam.	
EMERGENCY GATE	Valve on downstream end of 12" diameter cast iron pipe.	Positive upstream closure should be provided for the drainline, or the pipe should be plugged and some other means devised to drain the reservoir.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The existing spillway is a temporary structure. The temporary spillway exists of a trapezoidal shaped, earth cut channel.	
APPROACH CHANNEL	Lake [earthen berm with culvert pipes exist at the entrance to the channel].	Assume earthen berm erodes during hydrologic and hydraulic analysis of spillway.
DISCHARGE CHANNEL	300 foot long trapezoidal channel.	Design drawings of modifications to the structure indicate that riprap is to be added to the channel bottom.
BRIDGE AND PIERS	None.	Owner reports that a bridge is planned to cross the spillway.

GATED SPILLWAY - NOT APPLICABLE

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

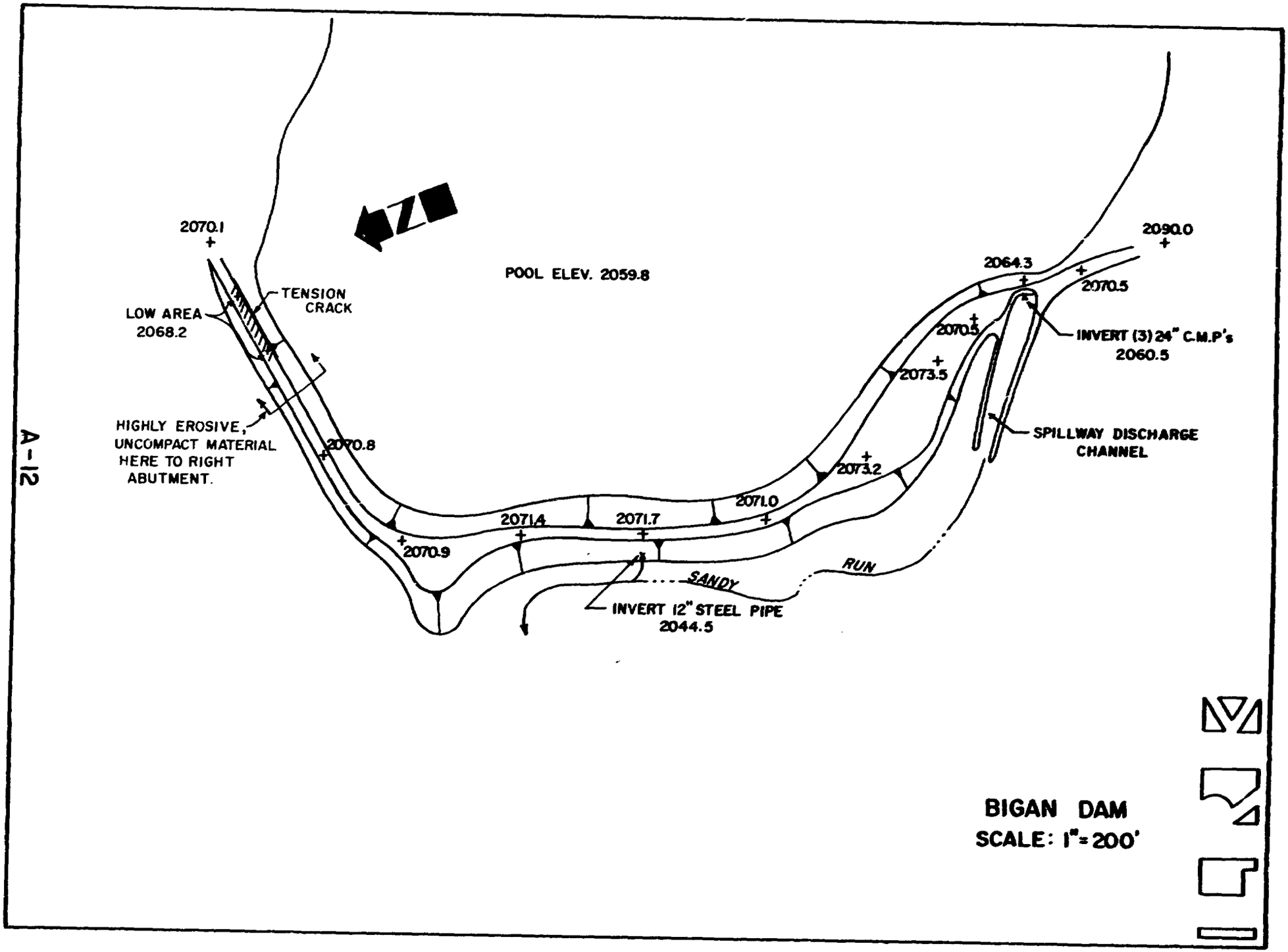
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The discharge channel for the Bigan Dam discharges flow from the spillway into the natural stream below the dam. No major obstructions were noted in the discharge channel.	
SLOPES	Appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	One home is located approximately 500 feet downstream and west of the dam. Two additional homes are located within two miles downstream of the dam. Downstream conditions indicate that loss of more than a few lives, and significant property damage is probable should the structure fail.	The one home located approximately 500 feet downstream and west of the dam is estimated to exist approximately 2040.2 contour.

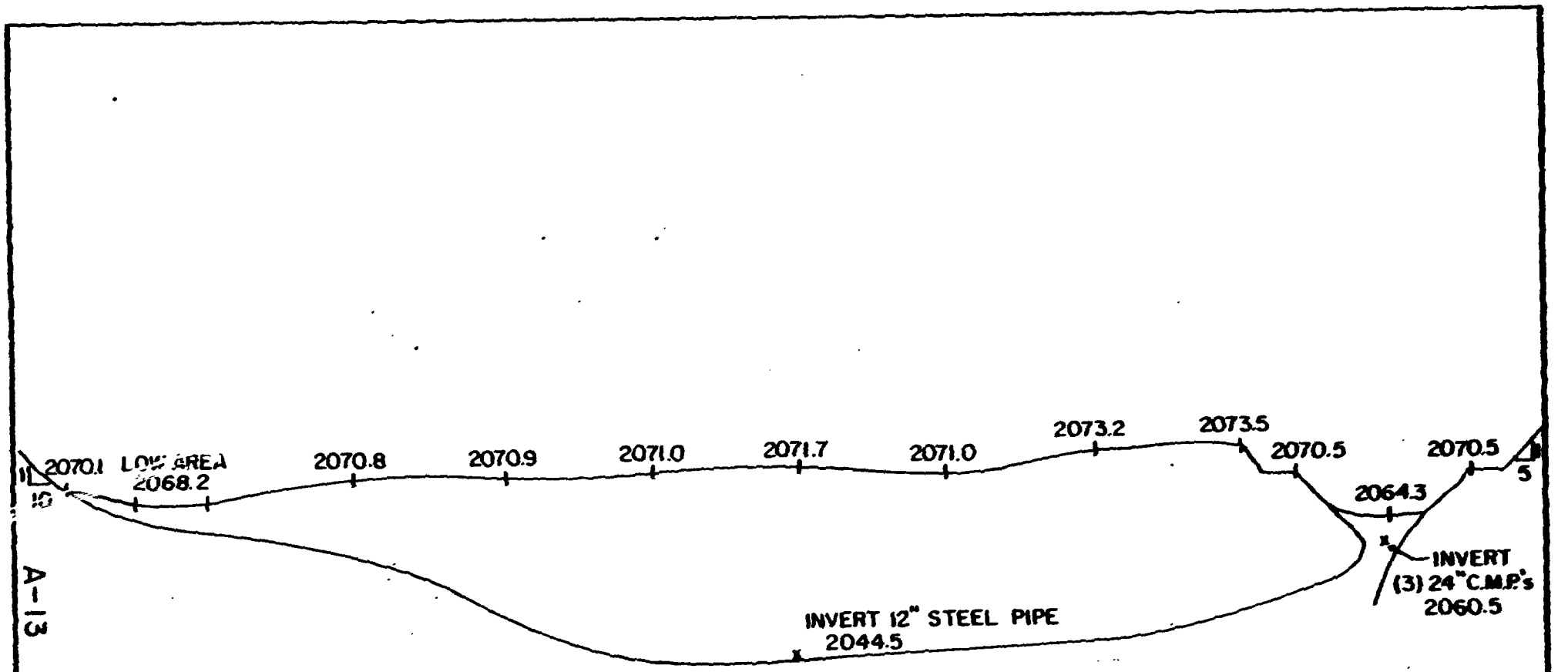
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate.	
SEDIMENTATION	Unknown.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	


2070.1
POOL ELEV. 2059.8
2090.0
2064.3
2070.5
TENSION CRACK
LOW AREA 2068.2
2070.5
INVERT (3) 24" C.M.P's 2060.5
2073.5
HIGHLY EROSIVE, UNCOMPACT MATERIAL HERE TO RIGHT ABUTMENT.
2070.8
SPILLWAY DISCHARGE CHANNEL
2073.2
2071.0
2071.4
2071.7
2070.9
SANDY RUN
INVERT 12" STEEL PIPE 2044.5
BIGAN DAM
SCALE: 1"=200'



PROFILE
LOOKING UPSTREAM
SCALE: HORIZ. 1"=200'
VERT. 1"= 20'

BIGAN DAM

APPENDIX B
CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Bigan Dam

ID# PA 237

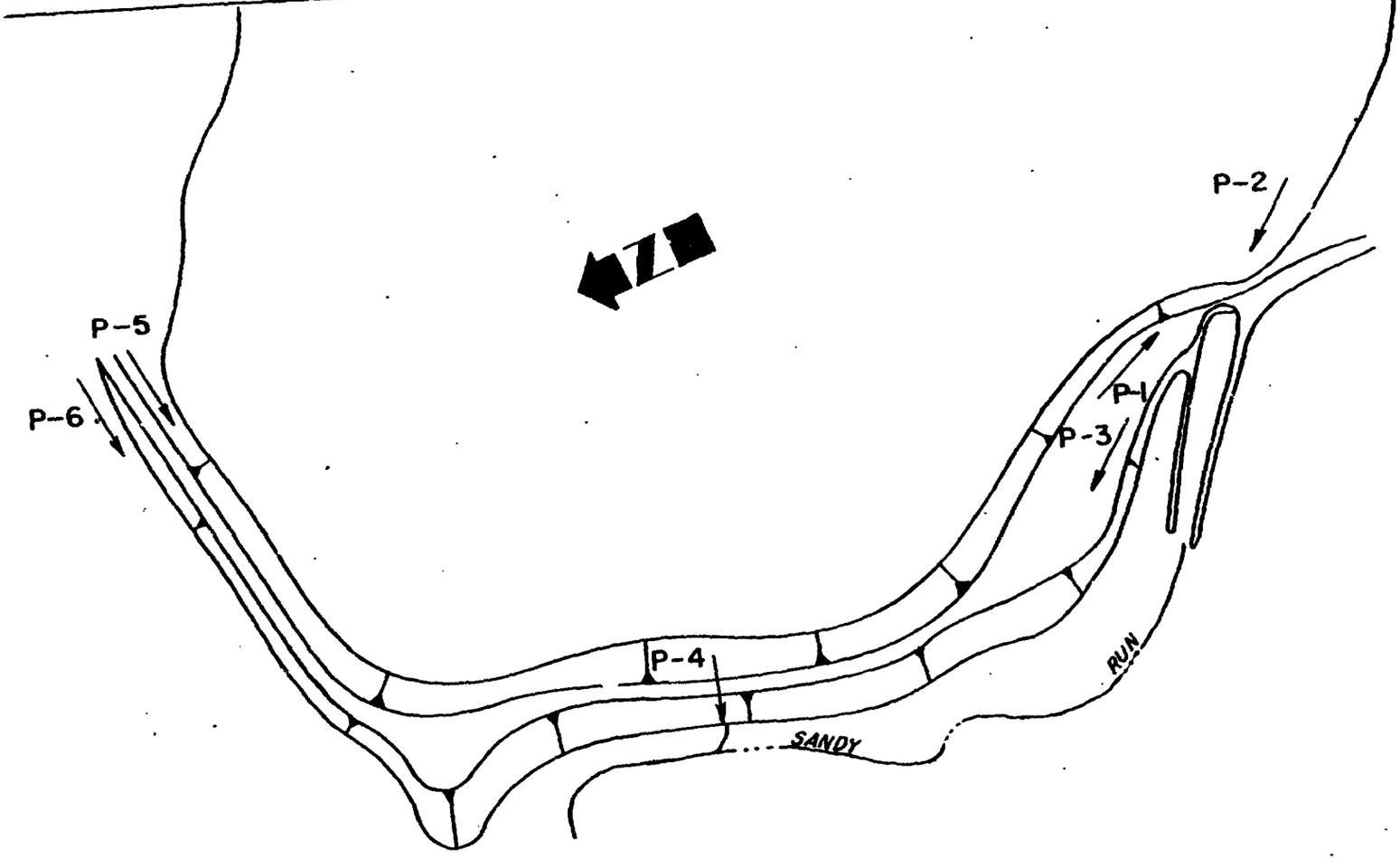
ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. quadrangle.
CONSTRUCTION HISTORY	None available.
TYPICAL SECTIONS OF DAM	See Appendix E.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	See Appendix E. See Appendix E. See Appendix E. None. None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None.
POST-CONSTRUCTION SURVEYS OF DAM	Surveys completed relative to current design modifications.
BORROW SOURCES	Reservoir area.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Dam is currently being modified. Modifications to embankment and spillway.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None known to have occurred.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Dam was overtopped during July, 1977. Minimal damage to the embankment. No detailed description or reports available.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	See Appendix E.
OPERATING EQUIPMENT PLANS & DETAILS	None.

APPENDIX C
PHOTOGRAPHS



C-1

BIGAN DAM
PHOTO INDEX

P- INDICATES PHOTO LOCATION

BIGAN DAM
PA 237

Sheet 1

Front

(1) Upper left - View of spillway approach. View towards the left abutment.
(2) Upper right - Close-up view of spillway approach and earthen berm across the approach to spillway. Note three corrugated metal pipes through the earthen berm.
(3) Lower left - View of across the crest of the dam. View towards the northwest.
(4) Lower right - Outlet for drainline. Note valve at outlet.

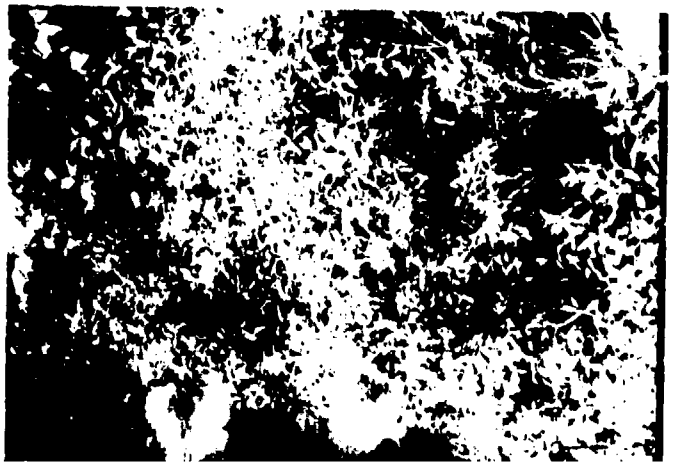
Sheet 1

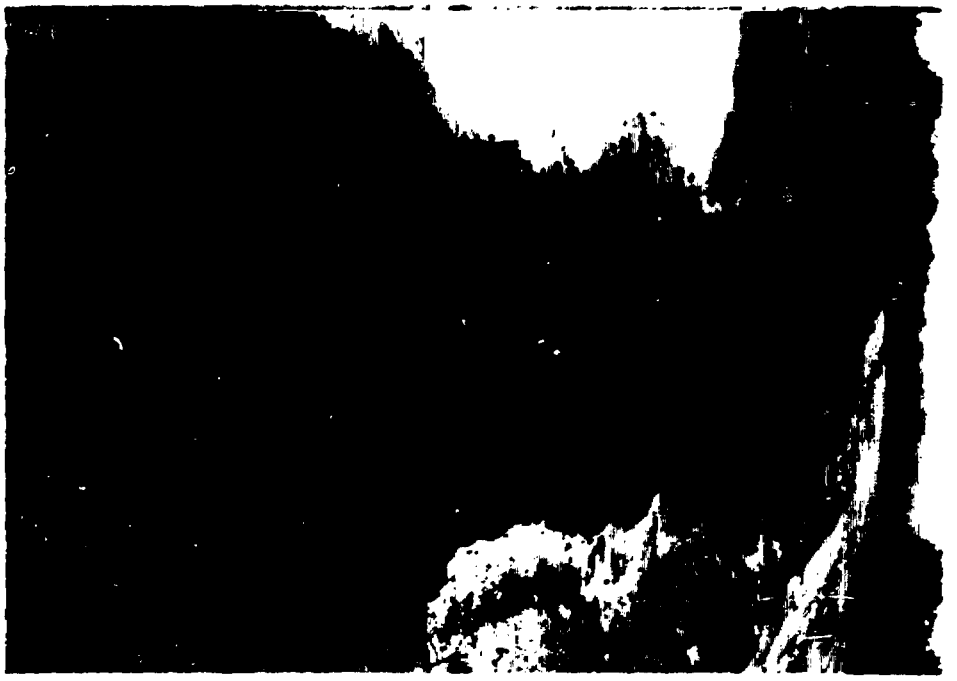
Back

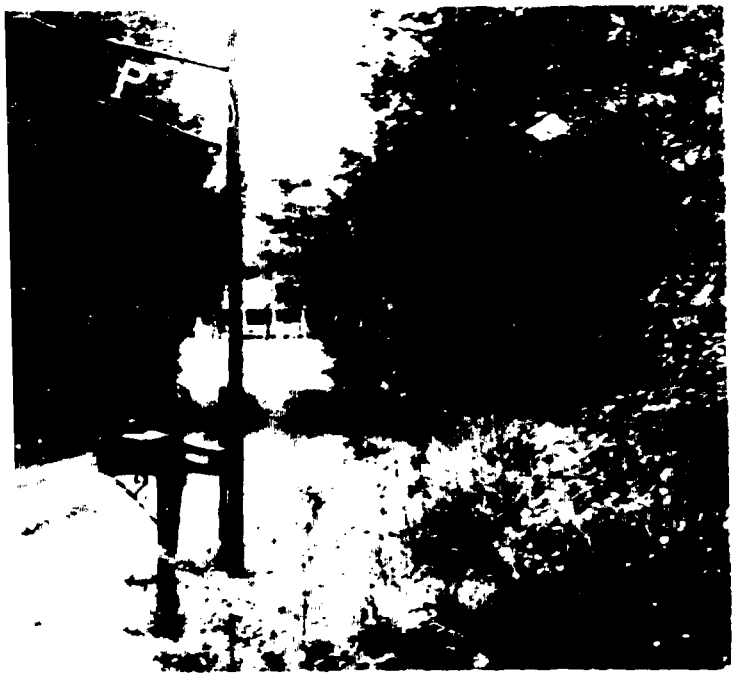
(5) Upper left - View of tension crack along upstream edge of crest. View towards the west.
(6) Upper right - View along the downstream slope of the northern embankment. View towards the west.
(7) Lower left - Downstream exposure.
(8) Lower right - Downstream exposure.

TOP OF PAGE

1,5	2,6
3,7	4,8







APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 33" prepared by the U.S. Weather Bureau.

The index rainfall may be reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input, or sufficient dimensions input, and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF, the computer program will calculate the percentage of the PMF, which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY AND HYDRAULICS ANALYSIS
DATA BASE

NAME OF DAM: Bigan Dam

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24.0 inches

STATION	1	2	3
Station Description	Bigan		
Drainage Area (square miles)	2.0		
Cumulative Drainage Area (square miles)	2.0		
Adjustment of PMF for Drainage Area (%) (1)	(Zone 7)		
6 hours	102		
12 hours	120		
24 hours	130		
48 hours	140		
72 hours	N/A		
Snyder Hydrograph Parameters			
Zone (2)	24		
Cp (3)	0.45		
Ct (3)	1.60		
L (miles) (4)	1.61		
Lca (miles) (4)	0.57		
tp = Ct(LxLca) 0.3 hrs.	1.56		
Spillway Data (temporary spillway)			
Crest Length (ft)	38		
Freeboard (ft)	7.7		
Discharge Coefficient	C'=0.95		
Exponent	N/A		

(1) Hydrometeorological Report 33 (Figure 1), U.S. Weather Bureau and U.S. Army Corps of Engineers, 1956.
(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients (C_p and C_t).
(3) Snyder's Coefficients.
(4) L=Length of longest water course from outlet to basin divide.
L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 2.0 sq.mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 2060.5 [55 ac-ft]

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 2068.2 [210 ac-ft]

ELEVATION MAXIMUM DESIGN POOL: 2070.0 [proposed]

ELEVATION TOP DAM: 2068.2 [low spot]

SPILLWAY CREST:

a. Elevation 2060.5
b. Type Trapezoidal channel
c. Width Bottom width = 38 feet
d. Length Not applicable
e. Location Spillover Left abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 12" diameter cast iron pipe
b. Location ~~Mid-embankment~~
c. Entrance inverts Unknown
d. Exit inverts 2044.5
e. Emergency drawdown facilities 12" diameter cast iron pipe

HYDROMETEOROLOGICAL GAUGES:

a. Type None
b. Location None
c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

Note: Elevations refer to MSL.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

NAME EIGHT DAM
NUMBER 82-257
SHEET NO. 1 OF
BY DTW DATE 2-91

INFLOW RATE AND BASE FLOW PARAMETERS

STRTL = 1 INCH
CNSTL = 0.05 IN/HR
STRTQ = 1.5 CFS/SQ MI
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

AS RECOMMENDED BY THE SALT LAKE DISTRICT CORPS OF ENGINEERS.

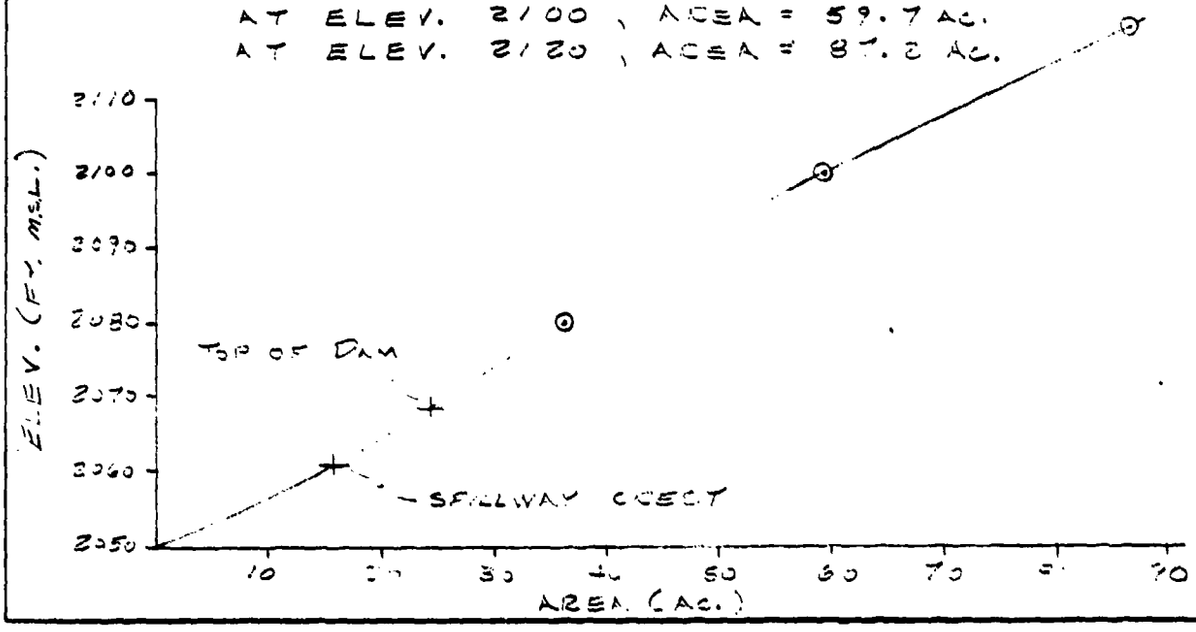
ELEVATION-AREA-CAPACITY RELATIONSHIPS

FROM U.S.G.S. 7.5 MIN. QUAD., DEC FILE AND FIELD INSPECTION DATA.

SPILLWAY CREST:

EARTHEN TRAPEZOIDAL CHANNEL = 30.0 FT.
ZERO STORAGE AT ELEVATION 2059.0 (EST.)

AT ELEV. 2080, AREA = 36.7 AC.
AT ELEV. 2100, AREA = 59.7 AC.
AT ELEV. 2120, AREA = 87.2 AC.



L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

NAME
NUMBER 92.-257
SHEET NO. 2 OF
BY DAN DATE 6-81

AREA (AC)	0	15.8	24.6	36.7	57.7	87.2
ELEV. (FT.)	2050	2060.5	2068.2	2080	2100	2120

DISCHARGE RATING CURVE

NOTE: ASSUME TEMPORARY EARTHEN DIKE AT THE APPROACH TO CHANNEL EDGES AWAY.

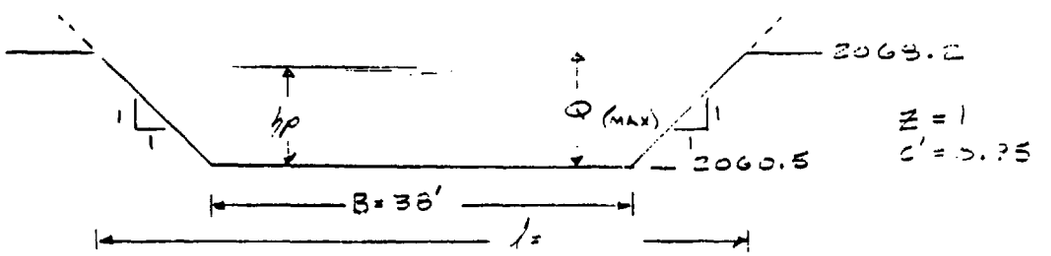
TRAPEZOIDAL FLOW (Q): $Q_{(MAX.)} = 920$ c.f.s.

$$Q = 3.03\, C' h_v^{1/2} (h_p - h_v)\left[B + \tfrac{1}{2}(h_p - h_v)\right]$$

WHERE, $$h_v = \frac{3(2Zh_p + B) - \left(16Z^2h_p^2 + 16Zh_pB + 9B^2\right)^{1/2}}{10Z}$$

FLOW, WATER & WASTEWATER ENGINEERING (VOL. 1, P. 11-5) by FAIR, GEYER & OKUN, 1966

LOW DAMS (EM 7 & 8) by NATIONAL RESOURCE COMM., WASH., D.C., 1953



SPILLWAY PROFILE
(SCALE AS SHOWN)

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

NAME
NUMBER EA-257
SHEET NO. 3 OF
BY DTR DATE 6-31

ELEV. (FT)	hp (cfs)	DISCHARGE *Q (cfs)
2060.5	0	0
2061.0	0.5	40
2062.0	1.5	210
2063.0	2.5	460
2064.0	3.5	730
2065.0	4.5	1150
2066.0	5.5	1580
2068.2	7.7	2710
2070.0	9.5	3820
2072.0	11.5	5250

*Q ROUNDED TO NEAREST 10 cfs.

OUTLET CONTROL

TO BE DETERMINED BY (HEC-1).

TOP OF DAM = 2068.2
COEFFICIENT OF DISCHARGE = 2.9 (ROUND CREST)

$L	100	300	1210	1430
$Y	2068.2	2070.0	2071.0	2072.0

```
*****   **********************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1                 A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF BIGAN DAM
    3                 A3       RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (PA-237)
    4                 B    288       0      10       0       0       0       0       0       0       0
    5                 B1     5
    6                 J      1       4       1
    7                 J1    .4      .5      .6       1
    8                 K      0       1                                       1
    9                 K1       INFLOW
   10                 M      1       1       2                       1                               1
   11                 P              24     102     120     130     140
   12                 I                                                       1.0     0.05
   13                 W   1.56    0.45
   14                 X   -1.5    -.05       2
   15                 K      1       2                                       1
   16                 K1       ROUTE
   17                 Y                                       1       1
   18                 Y1     1                                                -2060.5      -1
   19                 Y42060.5    2061    2062    2063    2064    2065    2066  2068.2    2070    2072
   20                 Y5     0      40     210     460     780    1160    1580    2710    3820    5250
   21                 SA     0    15.8    24.6    36.7    59.7    87.7
   22                 SE  2050 2060.5  2068.2    2080    2100    2120
   23                 SS2060.5
   24                 SD2068.2     2.9     1.5     100
   25                 SL   100     300    1210    1480
   26                 SV2068.2    2070    2071    2072
   27                 K     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE 81/07/13.
TIME 08.59.05.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF BIGAN DAM
RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (PA-237)

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .40 .50 .60 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.00	0.00	2.00	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.56 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 9.94 AND R=14.81 INTERVALS

UNIT HYDROGRAPH 84 END-OF-PERIOD ORDINATES, LAG= 1.57 HOURS, CP= .45 VOL= 1.00

11.	43.	88.	141.	200.	260.	310.	349.	373.	379.
365.	341.	319.	298.	278.	260.	243.	227.	213.	199.
186.	174.	162.	152.	142.	132.	124.	116.	108.	101.
94.	88.	83.	77.	72.	67.	63.	59.	55.	51.
48.	45.	42.	39.	37.	34.	32.	30.	28.	26.
24.	23.	21.	20.	19.	17.	16.	15.	14.	13.
12.	12.	11.	10.	10.	9.	8.	8.	7.	7.
6.	6.	6.	5.	5.	5.	4.	4.	4.	3.
3.	3.	3.	3.						

HYDROGRAPH ROUTING

ROUTE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-2061.	-1

STAGE	2060.50	2061.00	2062.00	2063.00	2064.00	2065.00	2066.00	2068.20	2070.00
M 2072.00									
FLOW	0.00	40.00	210.00	460.00	780.00	1150.00	1580.00	2710.00	3820.00
5250.00									
SURFACE AREA=	0.	16.	25.	37.	60.	87.			
CAPACITY=	0.	55.	210.	569.	1524.	2984.			
ELEVATION=	2050.	2061.	2068.	2080.	2100.	2120.			

CRLL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
2060.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
2068.2	2.9	1.5	100.

PEAK OUTFLOW IS 2179. AT TIME 41.83 HOURS

PEAK OUTFLOW IS 2721. AT TIME 41.83 HOURS

PEAK OUTFLOW IS 3364. AT TIME 41.67 HOURS

PEAK OUTFLOW IS 5266. AT TIME 41.33 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .40	RATIO 2 .50	RATIO 3 .60	RATIO 4 1.00
HYDROGRAPH AT	1	2.00 (5.18)	1	2317. (65.61)	2896. (82.01)	3476. (98.42)	5793. (164.03)
ROUTED TO	2	2.00 (5.18)	1	2179. (61.70)	2721. (77.05)	3364. (95.25)	5764. (163.21)

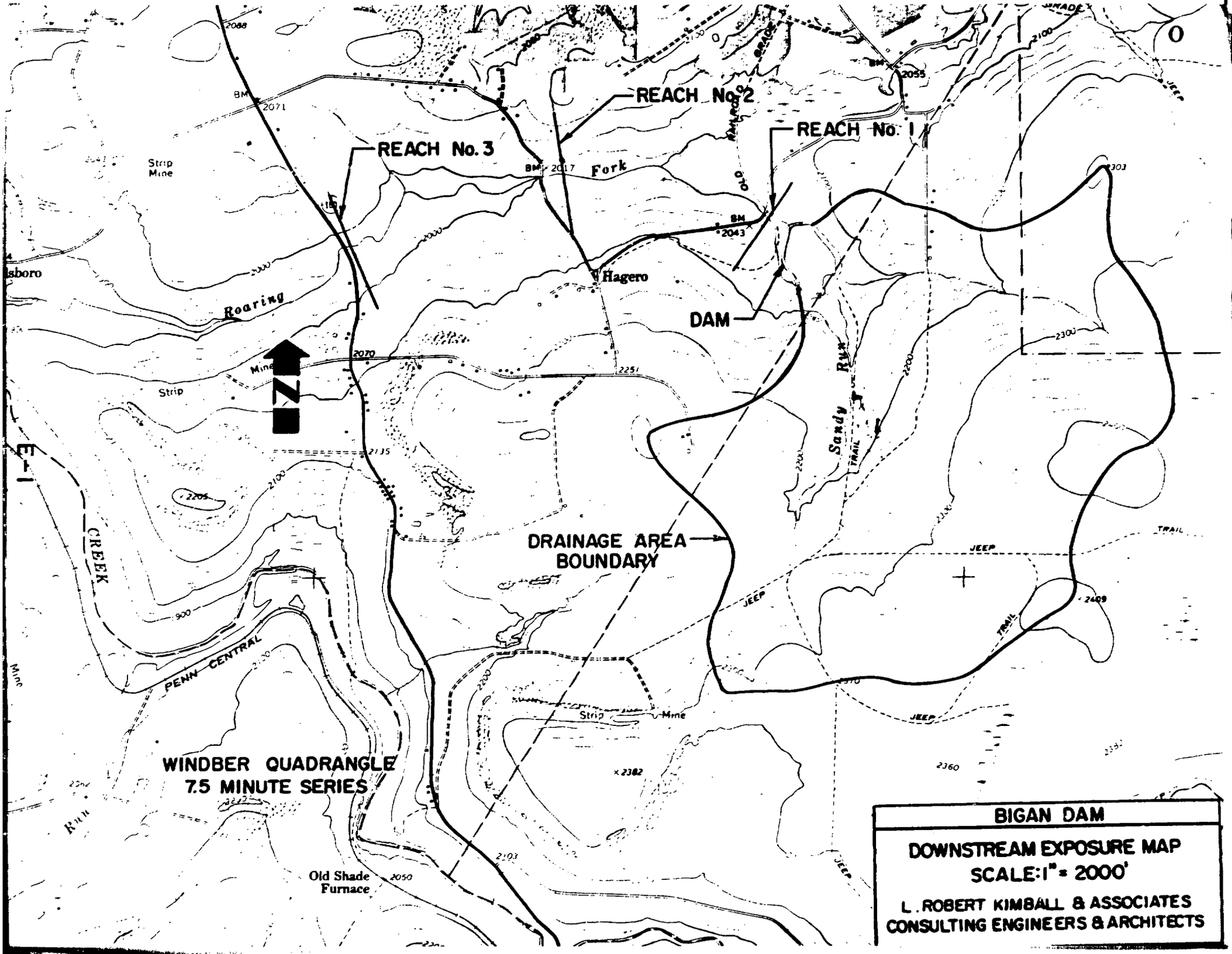
SUMMARY OF DAM SAFETY ANALYSIS

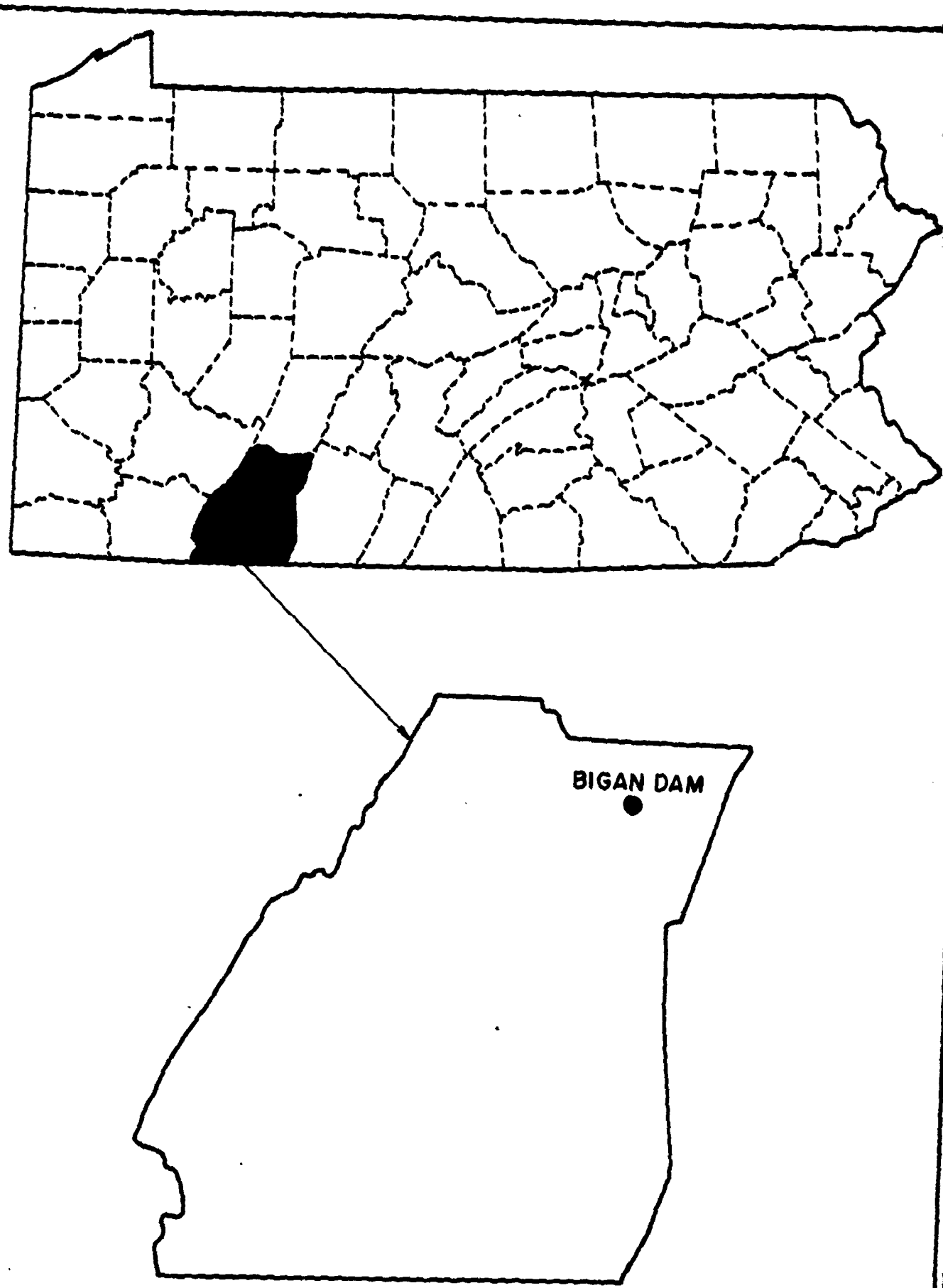
PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	2060.50	2060.50	2068.20
STORAGE	55.	55.	210.
OUTFLOW	0.	0.	2710.

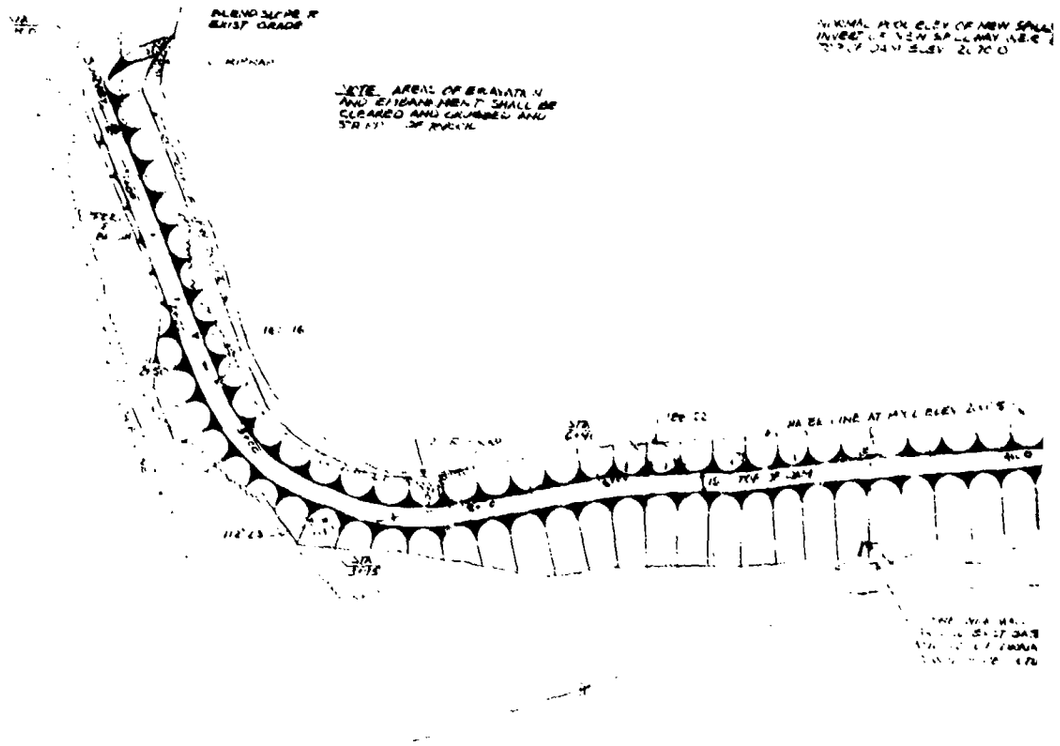
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	2067.17	0.00	185.	2179.	0.00	41.83	0.00
.50	2068.22	.02	210.	2721.	.33	41.83	0.00
.60	2068.89	.69	227.	3364.	2.33	41.67	0.00
1.00	2070.27	2.07	263.	5764.	5.00	41.33	0.00

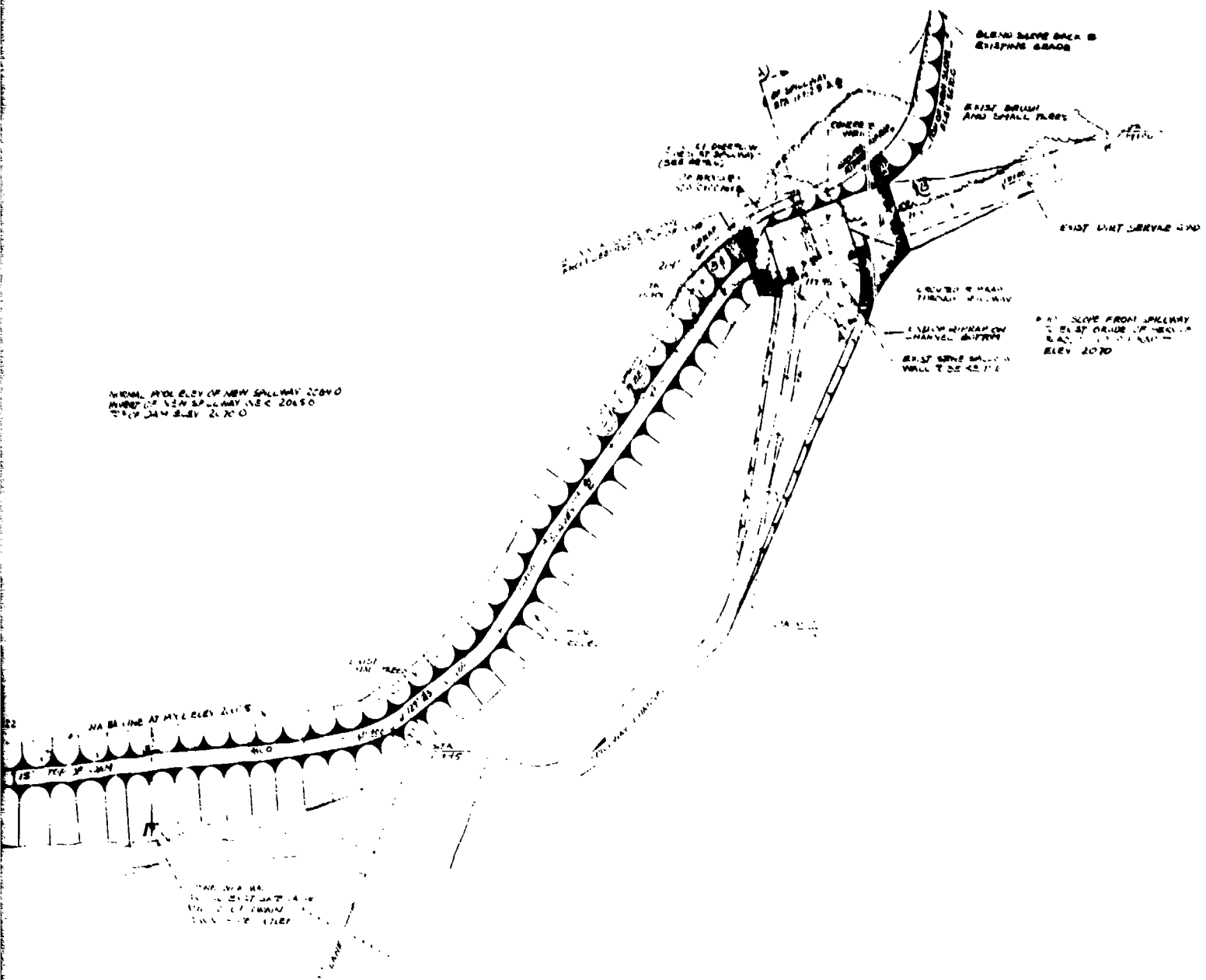
APPENDIX E
DRAWINGS


REACH No. 2
REACH No. 1
REACH No. 3
DAM
DRAINAGE AREA BOUNDARY
Hagero
Roaring
Fork
Sandy Run
Strip Mine
Old Shade Furnace
PENN CENTRAL
WINDBER QUADRANGLE
7.5 MINUTE SERIES
BIGAN DAM
DOWNSTREAM EXPOSURE MAP
SCALE: 1" = 2000'
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



SITE LOCATION MAP
SOMERSET COUNTY, PENNSYLVANIA
E-2

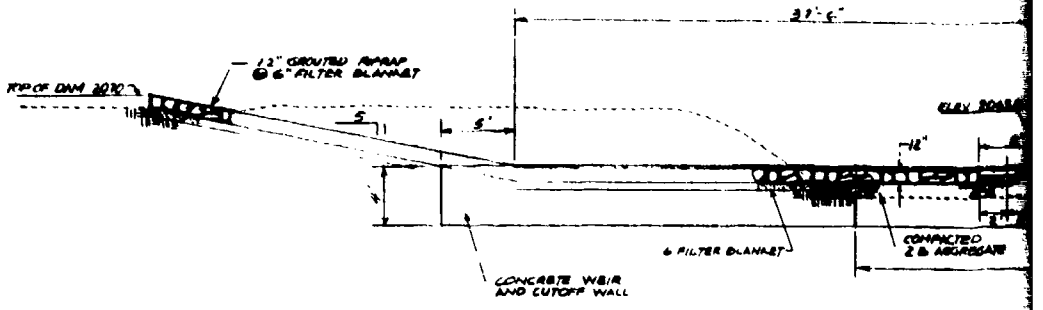




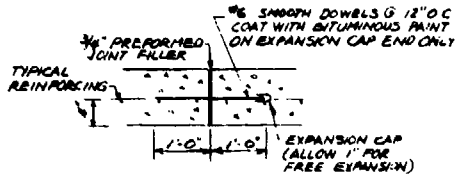
John Thomas Reilly

	PLAN
THE NEILAN ENGINEERS, INC. SOMERSET, PENNSYLVANIA	DESIGNED / DRAWN / CHECKED / APPROVED — SCALE: 1"=30' — DRAWING NO. 1

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

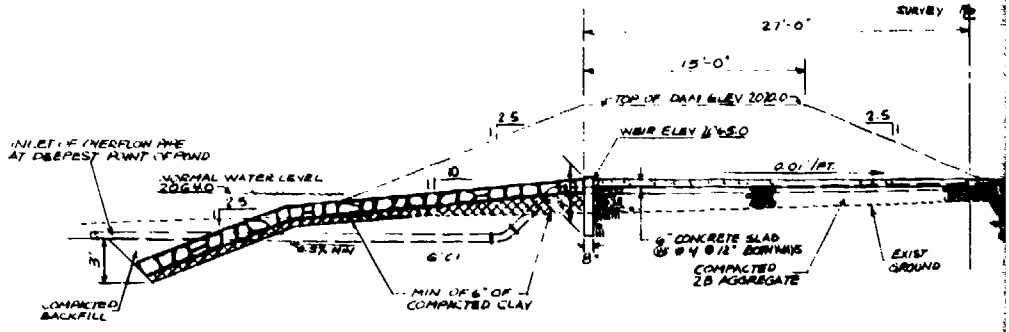


SPILLW
SCALE: 1

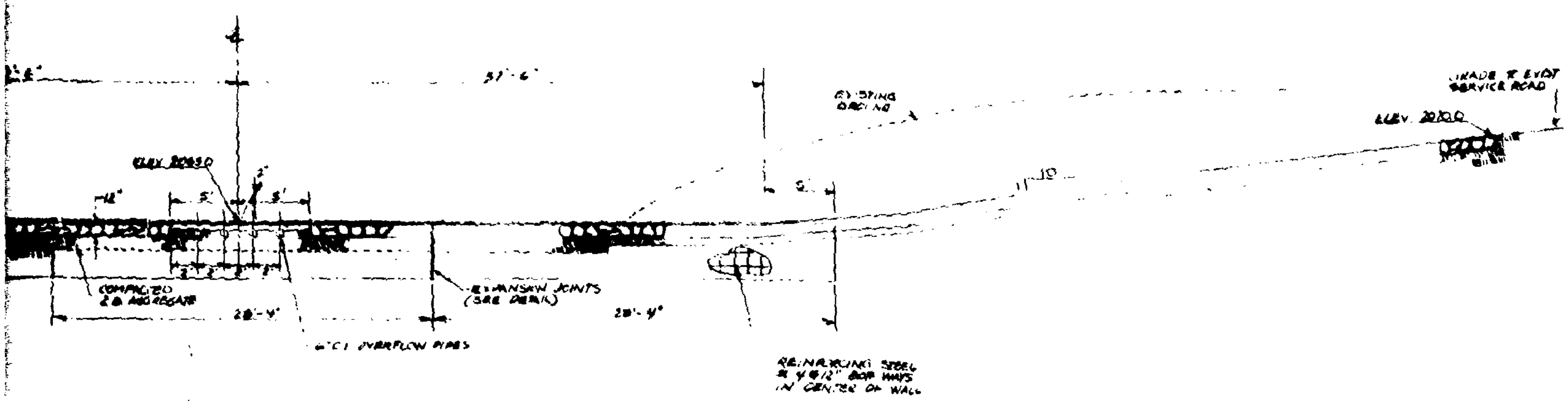


PLAN

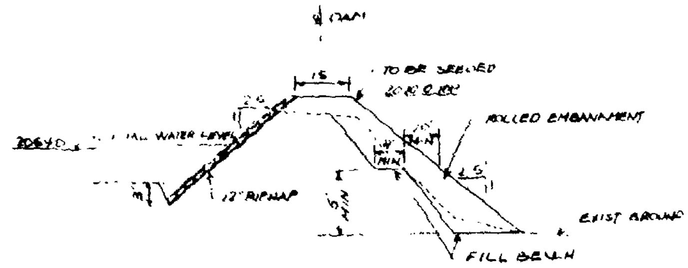
EXPANSION JOINT DETAIL
N.T.S



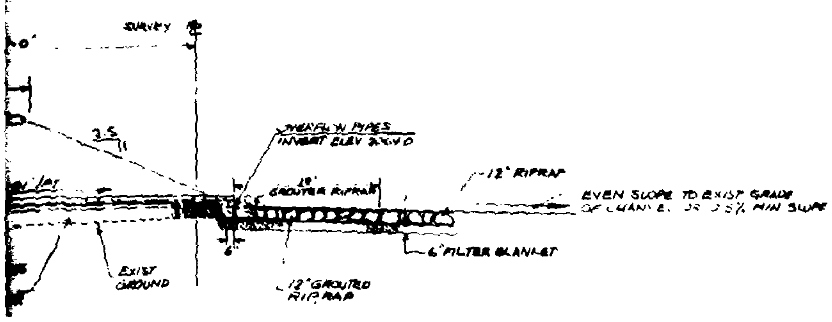
SECTION (A)(A)
SPILLWAY AND WEIR
SCALE: 1"=5'-0"



SECTION B-B
SPILLWAY AND WEIR



TYPICAL SECTION
EARTHEN DAM
N.T.S.



FLOOD DAMAGE REPAIRS MIKE BIGAN DAM SOMERSET COUNTY, PA	SECTIONS AND DETAILS
THE NEILAN ENGINEERS, INC. SOMERSET, PENNSYLVANIA	DESIGNED / DRAWN / CHECKED / APPROVED — SCALE: AS NOTED — DRAWING NO. 6

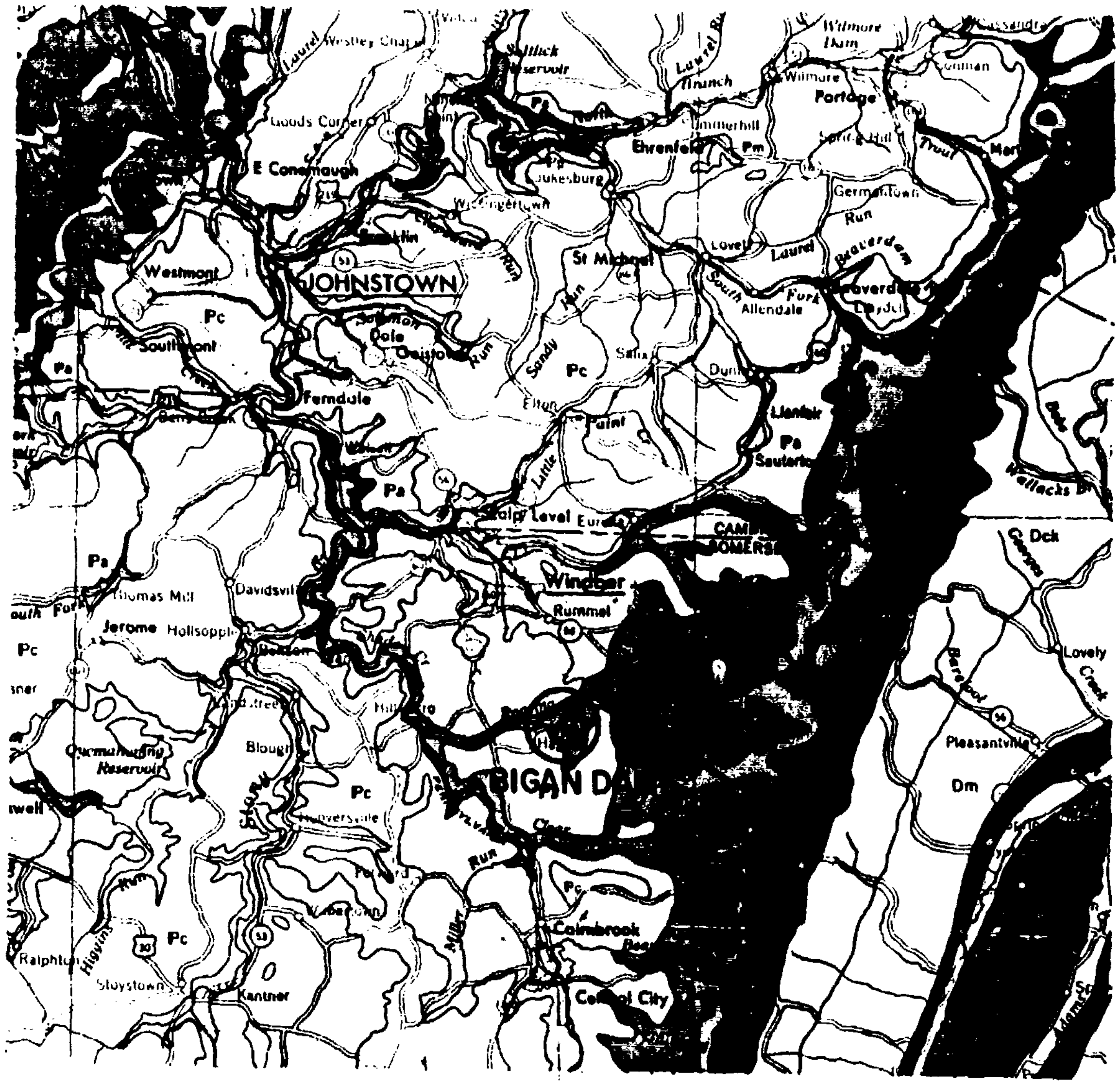
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

APPENDIX F
GEOLOGY

General Geology

The Bigan Dam is located in the Allegheny Mountain Section of the Appalachian Plateaus Province. This section lies between the Pittsburgh Plateaus Section to the west and Valley and Ridge Province to the east. It is typified by rather open folds with flank dips generally ranging between 5 and 20 degrees. The folding is more intense than the folding in the Pittsburgh Plateau Section, but is unlike the Valley and Ridge Province in that the valleys between the ridges stand relatively high and are underlain by rather gently inclined strata. Structurally, there is a parallelism of northeast-trending ridges. The Bigan Dam lies on the eastern limb of the Somerset Syncline about three miles north of where the Negro Mountain Anticline terminates; therefore the common limb becomes the Deer Park Anticline which lies on the other side of the Allegheny Front. The strike of the strata in the vicinity of the dam is about N27° E, with a dip of about 3° NW. No major faulting is sited in this area.

The rock underlying the Bigan Dam consists of fine grained to conglomerate quartzose sandstone with some cross-bedding. Such strata are at the horizon of the Upper Cononquenessing Sandstone of the Pottsville Group of Pennsylvanian Age. Rocks of the Pottsville Group lie above the Mississippian Mauch Chunk Formation and extend upward to the base of the Brookville coal or its underclay when present. This group consists of alternations of shale, minor coal, clay, and major sandstones and has an average thickness of 150 feet. The Upper Connonquenessing Sandstone lies about midway in this group. Coal beds of this group, such as the Quakertown or Sharon coals, are notably irregular in thickness and structure, and may also be composed of several benches of coal.



GEOLOGIC MAP OF THE AREA AROUND THE BIGAN DAM

SCALE 1:250,000

PENNSYLVANIAN

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections, Brush Creek Limestone in lower part of section.

Pa

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals, limestones thicken westward. Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations

Pp

Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals, some coals mineable locally.